PB-239 542

ARROWHEAD MOUNTAIN LAKE, CHITTENDEN AND FRANKLIN COUNTIES, VERMONT

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Vermont National Guard
Vermont State Agency of Environmental Conservation

July 1974

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

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and

NATIONAL ENVIRONMENTAL RESEARCH CENTER - LAS VEGAS, NEVADA

GPO—697-032

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. PB 239 542

4. TITLE AND SUBTITLE
Report on Arrowhead Mountain Lake, Chittenden & Franklin Counties

5. REPORT DATE
Prepared July 1974

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
Anonymous (National Eutrophication Survey Staff)

8. PERFORMING ORGANIZATION REPORT NO.
Working Paper # 17

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Pacific Northwest Environmental Research Laboratory
U.S.Environmental Protection Agency
200 S. W. 35th St.
Corvallis, Oregon 97330

10. PROGRAM ELEMENT NO.
1BA029

11. CONTRACT/GRANT NO.

12. SPONSORING AGENCY NAME AND ADDRESS
U.S. Environmental Protection Agency
Office of Research and Development
Washington, D.C.

13. TYPE OF REPORT AND PERIOD COVERED
Final - 1972

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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US Department of Commerce
Springfield, VA. 22151

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release unlimited	20. SECURITY CLASS *(This page)*	22. PRICE
		3.75-2.25

EPA Form 2220-1 (9-73)

REPORT

ON

ARROWHEAD MOUNTAIN LAKE

CHITTENDEN & FRANKLIN COUNTIES

VERMONT

EPA REGION I

WORKING PAPER No. 17

WITH THE COOPERATION OF THE

VERMONT AGENCY OF ENVIRONMENTAL CONSERVATION

AND THE

VERMONT NATIONAL GUARD

JULY, 1974

10

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FOREWORD

The National Eutrophication Survey was initiated in 1972 as a research project in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations and impact on selected fresh water lakes as a basis for formulating comprehensive and coordinated national, regional and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations and impacts can, in fact, be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

This report documents the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin. It is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/ standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Vermont Agency of Environmental Conservation for professional involvement and to the Vermont National Guard for conduct of the tributary sampling phase of the Survey.

Martin L. Johnson, Secretary of the Vermont Agency of Environmental Conservation; Gordon R. Ryper, Commissioner of the Water Quality Division; David L. Clough, Director, James W. Morse II, Biologist, and Wally McLean, Sanitary Engineer of the Water Quality Division, provided invaluable lake documentation and counsel during the study. Reginald A. LaRosa, Director of the Water Supply and Pollution Control Division, and James F. Agan, Chief of the Operations Section of the Environmental Engineering Division, were most helpful in arranging for the sampling of wastewater treatment plants involved in the Survey.

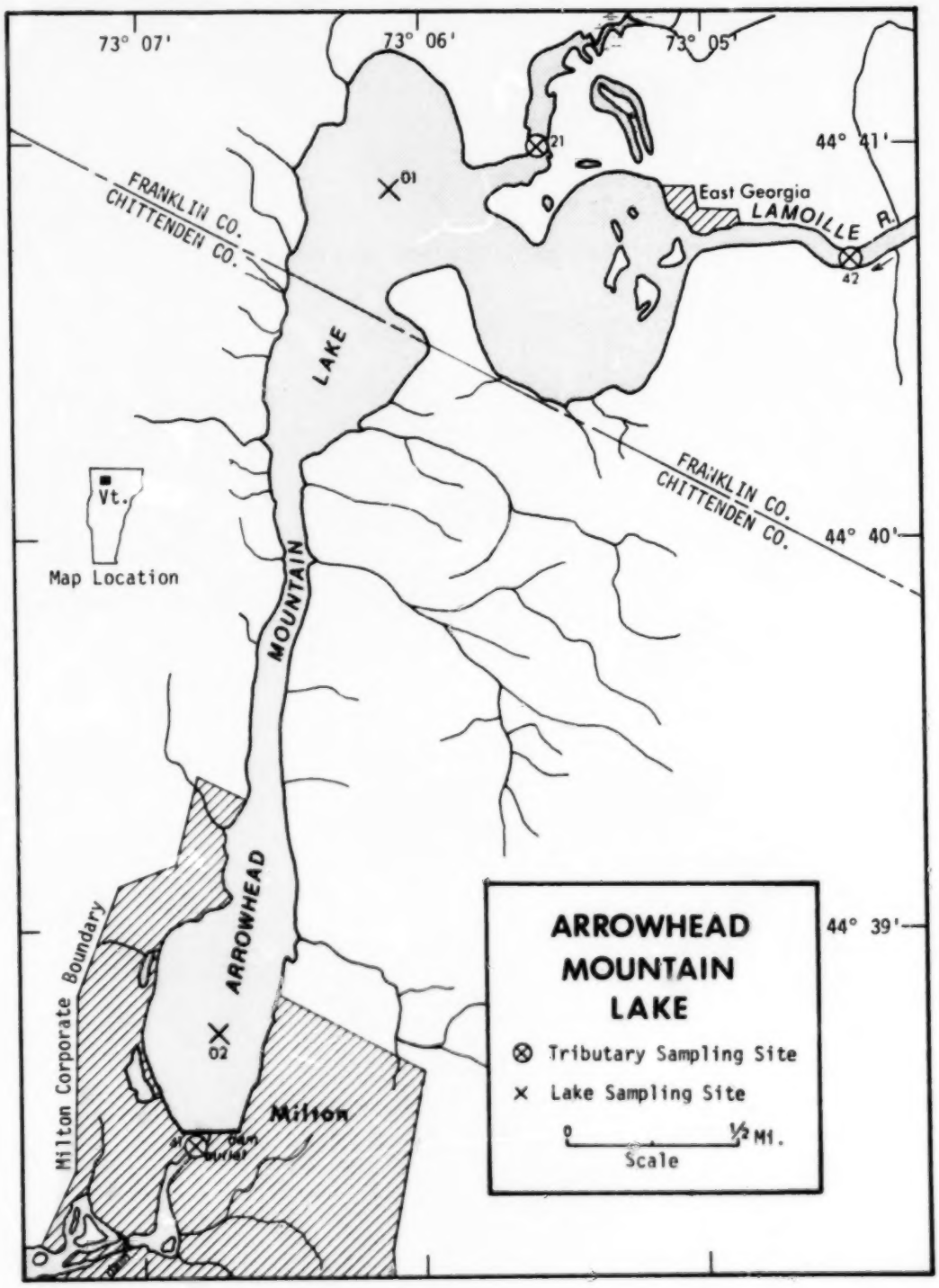
Major General Reginald M. Cram, the Adjutant General of Vermont, and Project Officer Major Howard Buxton, who directed the volunteer efforts of the Vermont National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

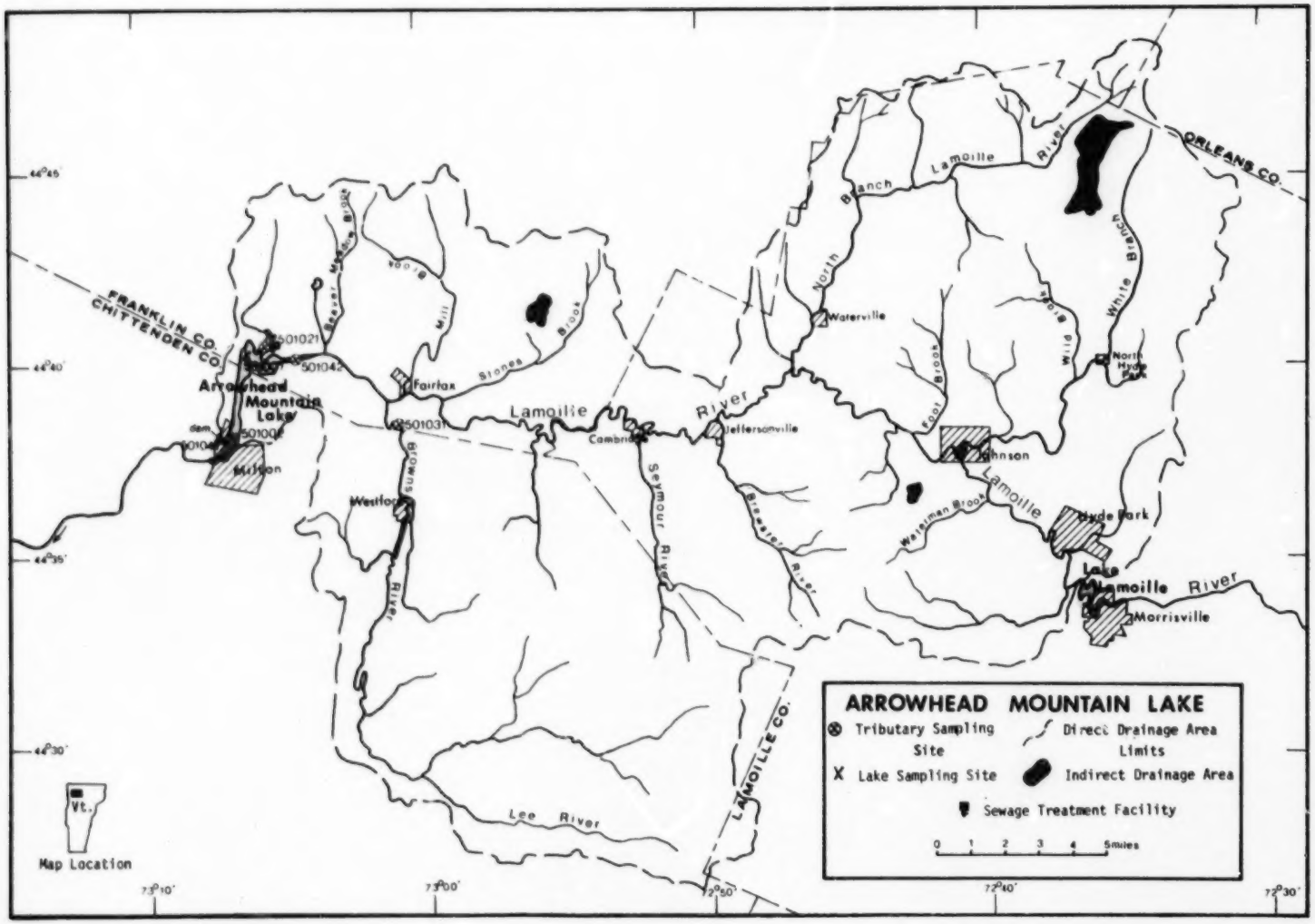
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF VERMONT

LAKE NAME	COUNTY
Arrowhead Mountain Lake	Chittenden, Franklin
Clyde Pond	Orleans
Harriman Reservoir	Windham
Lake Champlain	Addison, Chittenden, Franklin
Lake Lamoille	Lamoille
Lake Memphremagog	Orleans
Waterbury Reservoir	Washington


73° 07'
73° 06'
73° 05'
44° 41'
44° 40'
44° 39'
21
01
42
East Georgia
LAMOILLE R.
FRANKLIN CO.
CHITTENDEN CO.
LAKE
MOUNTAIN
ARROWHEAD
Vt.
Map Location
Milton Corporate Boundary
02
Milton
ARROWHEAD MOUNTAIN LAKE
Tributary Sampling Site
Lake Sampling Site
0
½ Mi.
Scale


ARROWHEAD MOUNTAIN LAKE
Tributary Sampling Site
Lake Sampling Site
Direct Drainage Area Limits
Indirect Drainage Area
Sewage Treatment Facility
0 1 2 3 4 5miles
Map Location
Vt.
FRANKLIN CO.
CHITTENDEN CO.
ORLEANS CO.
LAMOILLE CO.
Arrowhead Mountain Lake
Milton
Fairfax
Westford
Cambridge
Jeffersonville
Waterville
Johnson
Hyde Park
Lake Lamoille
Morrisville
Lamoille River
Lee River
Seymour River
Brewster River
Stones Brook
Mill Brook
Sandy Meadow Brook
North Branch Lamoille River
Waterman Brook
East Brook
Wild Branch
White Brook
501021
501042
501031
501001
dam
44°45'
44°40'
44°35'
44°30'
73°10'
73°00'
72°50'
72°40'
72°30'

ARROWHEAD MOUNTAIN LAKE

STORET NO. 5010

I. CONCLUSIONS

A. Trophic Condition:

Arrowhead Mountain Lake is a eutrophic body of water, but major nuisance conditions have not developed because of the very short hydraulic retention time of 3.5 days.

B. Rate-Limiting Nutrient:

Because of the atypical growth response of the test alga, Selenastrum capricornutum, the algal assay results are not considered a reliable indicator of the limiting nutrient. However, the lake data indicate phosphorus limitation at all sampling times; i.e., N/P ratios were 22/1 or greater, and phosphorus limitation would be expected.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Arrowhead Mountain Lake received a total phosphorus load at a rate more than ten times greater than a eutrophic rate (see page 15). Point sources contributed less than 30% of the load, and it is calculated that even complete removal of phosphorus at the point sources would only reduce the loading rate to seven times a eutrophic rate. Therefore, it is concluded that phosphorus control at the point sources would not result in a significant improvement in the trophic condition of the lake.

Provision of waste treatment facilities is underway at the point sources that discharged raw sewage during the Survey (see page 16).

2. Non-point sources--The mean annual non-point phosphorus exports in streams in the Arrowhead Mountain Lake drainage are somewhat higher than those of other Vermont systems studied (see pages 15 and 16). The cause of these higher exports is not apparent, but the rather high drainage area/lake area ratio of 538/1 will insure an excessive phosphorus loading to the lake until inputs from non-point sources can be reduced.

II. INTRODUCTION

Arrowhead Mountain Lake is an impoundment of the Lamoille River formed in 1937 by the construction of the Clark Falls dam at the Village of Milton to provide a 42-foot head for power generation (see map, page v).

The lack of convenient access and boat-launching facilities limits the present recreational use of the lake, and most of the fishing is done in the winter. There is very little development along the lake shore.

No major algal blooms, fish kills, or other nuisance conditions have been reported, even though the lake has received raw sewage directly and indirectly and treated wastes indirectly.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry:

1. Surface area: 826 acres.
2. Mean depth: 10.3 feet.
3. Maximum depth: 33 feet.
4. Volume: 8,508 acre/feet.
5. Mean hydraulic retention time: 3.5 days.

B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

Name	Drainage area*	Mean flow*
Lamoille River	686.0 mi^2	1,189.9 cfs
Unnamed Stream	8.5 mi^2	14.7 cfs
Minor tributaries & immediate drainage -	5.2 mi^2	11.3 cfs
Totals	699.7 mi^2	1,215.9 cfs

2. Outlet -

Lamoille River	701.0 mi^2**	1,215.9 cfs

C. Precipitation†:

1. Year of sampling: 43.4 inches.
2. Mean annual: 33.8 inches.

---

* Drainage areas are accurate within ±1%; gaged flows are accurate within ±15% and ungaged flows are accurate within ±20%.
** Includes area of lake.
† See Working Paper No. 1, "Survey Methods".

IV. LAKE WATER QUALITY SUMMARY

Arrowhead Mountain Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and usually from several depths at each station (see map, page v). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. Maximum depths sampled were 5 feet at station 1 and 24 feet at station 2.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

		FALL VALUES (10/05/72)		
Parameter	Minimum	Mean	Median	Maximum
Temperature (Cent.)	14.0	14.6	14.6	15.1
Dissolved oxygen (mg/l)	7.3	8.0	8.0	8.8
Conductivity (μmhos)	155	156	155	158
pH (units)	6.8	6.9	7.0	7.0
Alkalinity (mg/l)	44	46	46	48
Total P (mg/l)	0.013	0.032	0.017	0.079
Dissolved P (mg/l)	0.004	0.007	0.007	0.009
NO_2 + NO_3 (mg/l)	0.120	0.134	0.120	0.160
Ammonia (mg/l)	0.040	0.048	0.040	0.060
		ALL VALUES		
Secchi disc (inches)	52	63	64	72

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/20/72	1. Synedra	1,355
	2. Chroococcus	753
	3. Dinobryon	648
	4. Flagellates	482
	5. Rhaphidiopsis	166
	Other genera	527
	Total	3,931
07/31/72	1. Dinobryon	733
	2. Cryptomonas	131
	3. Flagellates	95
	4. Merismopedia	80
	5. Gloeocapsa	50
	Other genera	267
	Total	1,356
10/05/72	1. Fragilaria	964
	2. Flagellates	753
	3. Melosira	467
	4. Dinobryon	392
	5. Cyclotella	211
	Other genera	707
	Total	3,494

2. Chlorophyll *a* -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
06/02/72	01	20.5
	02	8.1
07/31/72	01	5.0
	02	11.7
10/05/72	01	2.5
	02	3.1

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.014	0.210	0.2
0.006 P	0.020	0.210	0.7
0.012 P	0.026	0.210	2.8
0.024 P	0.038	0.210	4.4
0.060 P	0.074	0.210	4.9
0.060 P + 10.0 N	0.074	10.210	29.5
10.0 N	0.014	10.210	0.2

2. Discussion -

The control yield of the assay alga, *Selenastrum capricornutum*, indicates that the potential primary productivity of Arrowhead Mountain Lake was relatively low at the time the sample was collected. However, the growth of the test organism was atypical in the control sample and all spiked

samples, except for the combined N and P spike. For example, at the nutrient levels shown, the expected control yield would have been a rather high 6 mg/l dry weight; but the expected yield of the combined N-P spike sample would have been about 32 mg/l dry weight or essentially the same as that obtained in the assay. The cause of the atypical growth is not known.

The lake data indicate Arrowhead Mountain Lake was phosphorus limited at all sampling times; i.e., N/P ratios were 22/1 or greater, and phosphorus limitation would be expected.

D. Trophic Condition:

The apparent trophic condition of Arrowhead Mountain Lake is largely the result of the very short hydraulic retention time of 3.5 days, which accounts for the absence of major aquatic nuisance conditions despite a total phosphorus loading of about 100 lbs/acre/yr (11.3 $g/m^2/yr$).

V. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Vermont National Guard collected a monthly near-surface grab sample from each of the sites indicated on the map (page vi), except for the high runoff month of April when three samples were collected. Sampling was begun in July, 1972, and was completed in June, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the New England District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of the U.S. Geological Survey computer program for calculating stream loadings ("STATPAC")*. Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S) were estimated by using the nutrient loads, in $lbs/mi^2/year$, in the Unnamed Stream at station 21 and multiplying by the ZZ area in mi^2.

The operator of the Village of Johnson wastewater treatment plant provided monthly effluent samples and corresponding flow data. However, the untreated sewage discharges from the villages of Milton, Fairfax, Hyde Park, Cambridge, and Jeffersonville were not sampled during the

* See Working Paper No. 1, "Survey Methods".

Survey; nutrient loads attributed to these sources were estimated* and were assumed to have reached the lake during the sampling year.

Also, the discharges from the villages of Morrisville and Hardwick impact Lake Lamoille some 37 stream miles upstream from Arrowhead Mountain Lake, and the nutrient loads from these sources, minus the amounts retained in Lake Lamoille (20% phosphorus retention and 5% nitrogen retention), are assumed to have reached Arrowhead Mountain Lake as well.

In this report, the nutrient loads attributed to the Lamoille River are those measured at station 42 minus the upstream point-source loads.

The Milton Co-op Creamery, at Milton, discharges wash water only directly to the lake; this waste was not sampled during the Survey. Estimates of nutrients contributed by this source were based on 1/3 gallon of wastewater per pound of milk processed with a total nitrogen concentration of 70 mg/l and a total phosphorus concentration of 50 mg/l (Boydston, 1973). Data on production at the Creamery were provided by personnel of the Vermont Department of Water Resources (Clough, 1973).

* See Working Paper No. 1, "Survey Methods".

A. Waste Sources:

1. Known municipal -

Name	Pop. Served*	Treatment	Mean Flow (mgd)	Receiving Water
Johnson	1,296	act. sludge	0.141	Lamoille River
Milton†	1,164	None	0.116*	Arrowhead Mtn. Lake
Fairfax	400	None	0.040*	Lamoille River
Hyde Park	418	None	0.042*	Lamoille River
Cambridge	235	None	0.024*	Lamoille River
Jeffersonville	382	None	0.038*	Lamoille River
Hardwick	1,503	None	0.150*	Lamoille River & Cooper Brook
Morrisville	2,116	None	0.212*	Lake Lamoille

2. Known industrial -

Name	Product	Treatment	Mean Flow (mgd)	Receiving Water
Milton Co-op Creamery	Cheese & dairy	None	0.061	Arrowhead Mtn. Lake

* Estimated; see Working Paper No. 1, "Survey Methods".
† One-half of Milton wastes are discharged to Lamoille River below Clark Falls dam.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Lamoille River	56,630	68.2
Unnamed Stream	910	1.1
b. Minor tributaries & immediate drainage (non-point load) -	560	0.7
c. Known municipal systems -		
Johnson STP	1,260	1.5
Milton	2,040	2.5
Fairfax	1,400	1.7
Hyde Park	1,460	1.8
Cambridge	820	1.0
Jeffersonville	1,340	1.6
Hardwick	2,100	2.5
Morrisville	5,930	7.1
d. Septic tanks* -	10	<0.1
e. Known industrial -		
Milton Co-op Creamery	8,380	10.1
f. Direct precipitation** -	130	0.2
Total	82,970	100.0

2. Outputs -

Lake outlet - Lamoille River 60,490

3. Net annual P accumulation - 22,480 pounds

* Estimated 16 shoreline dwellings; see Working Paper No. 1, "Survey Methods".
** Estimated; see Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/yr	% of total
a. Tributaries (non-point load) -		
Lamoille River	2,288,340	94.8
Unnamed Stream	30,210	1.3
b. Minor tributaries & immediate drainage (non-point load) -	18,480	0.8
c. Known municipal systems -		
Johnson STP	5,160	0.2
Milton	5,470	0.2
Fairfax	3,760	0.2
Hyde Park	3,930	0.2
Cambridge	2,210	0.1
Jeffersonville	3,590	0.1
Hardwick	12,080	0.5
Morrisville	18,900	0.8
d. Septic tanks* -	380	<0.1
e. Known industrial -		
Milton Co-op Creamery	11,730	0.5
f. Direct precipitation** -	7,960	0.3
Total	2,412,200	100.0

2. Outputs -

Lake outlet - Lamoille River 2,477,840

3. Net annual N loss - 65,640 pounds

* Estimated 16 shoreline dwellings; see Working Paper No. 1, "Survey Methods".

** Estimated; see Working Paper No. 1, "Survey Methods".

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs $P/mi^2/yr$	lbs $N/mi^2/yr$
Lamoille River	83	3,336
Unnamed Stream	107	3,554

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (1973). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

Units	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
lbs/acre/yr	100.4	27.2	2,920.3	loss*
grams/m^2/yr	11.26	3.05	327.3	-

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Arrowhead Mountain Lake:

"Dangerous" (eutrophic rate)	1.04
"Permissible" (oligotrophic rate)	0.52

* There was an apparent loss of nitrogen during the sampling year. This may have been due to nitrogen fixation in the lake, solubilization of previously sedimented nitrogen, recharge with nitrogen-rich ground water, unknown and unsampled point sources discharging directly to the lake, or underestimation of the nitrogen loads from the Village of Milton and/or the Milton Co-op Creamery. Whatever the cause, a similar nitrogen loss has occurred at Shagawa Lake, Minnesota, which had been intensively studied by EPA's National Eutrophication Research and Lake Restoration Branch.

F. Controllability of Nutrients:

1. Point sources--During the sampling year, Arrowhead Mountain Lake received a total phosphorus load at a rate more than ten times greater than a eutrophic rate. Of this load, it is calculated that the known point sources contributed a little less than 30%. Even complete removal of phosphorus at these sources would only reduce the loading rate to about 70 lbs/acre/yr or 7.9 $g/m^2/yr$ (a rate still more than seven times the eutrophic rate). It is concluded, therefore, that point-source control of phosphorus would not result in a significant improvement in the trophic condition of Arrowhead Mountain Lake unless non-point phosphorus export to the lake also can be reduced.

It is noted that at the time of preparation of this report, construction of secondary wastewater treatment facilities at the Village of Morrisville has been completed; plans for secondary treatment at the villages of Fairfax, Hardwick, and Hyde Park have been approved; and a preliminary engineering report on secondary treatment at the Village of Milton has been approved (Morse, 1974).

2. Non-point sources--The mean annual phosphorus exports of the Lamoille River subdrainage and the unnamed stream subdrainage (see page 15) are appreciably higher than those of unimpacted Vermont streams studied outside of the Lamoille drainage system (mean = 52 $lbs/mi^2/yr$; range = 30-65 $lbs/mi^2/yr$). Whether the native characteristics of the subdrainages, agricultural practices, or other factors are the cause of the higher export rates is not

known. Whatever the cause(s) may be, the rather high drainage area/lake area ratio of 538/1 will insure an excessive phosphorus load to the lake from the Lamoille River alone of 68 lbs/acre/yr (7.7 $g/m^2/yr$) until inputs from non-point sources (if amenable to control) can be reduced.

VII. LITERATURE REVIEWED

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Clough, David, 1973. Personal communication (area of Arrowhead Mountain Lake; land use in the Lamoille River Basin; amount of milk processed at Milton Co-op Creamery). Dept. of Water Resources, Montpelier.

Morse, James W., 1974. Personal communication (status of Vermont water pollution control facilities, Jan., 1974). Dept. Water Resources, Montpelier.

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TRIBUTARY FLOW INFORMATION FOR VERMONT 7/9/74

LAKE CODE 5010 LAKE ARROWHEAD

TOTAL DRAINAGE AREA OF LAKE 701.00

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
5010ZZ	6.52	7.82	6.36	14.00	35.70	17.50	8.33	5.46	5.08	5.77	8.35	11.50	9.26	11.31
501021	8.48	10.20	8.27	18.20	46.50	22.70	11.60	7.11	6.61	7.50	10.90	14.90	12.00	14.70
501041	701.00	841.00	683.00	1507.00	3841.00	1879.00	960.00	587.00	546.00	620.00	897.00	1234.00	995.00	1215.30
501042	686.00	822.00	669.00	1478.00	3760.00	1841.00	940.00	575.00	534.00	607.00	876.00	1210.00	973.00	1189.89

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 701.00
SUM OF SUB-DRAINAGE AREAS = 701.00
TOTAL FLOW IN = 14597.22
TOTAL FLOW OUT = 14590.00

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
5010ZZ	7	72	11.60						
	8	72	5.84						
	9	72	3.56						
	10	72	7.56						
	11	72	13.90						
	12	72	12.10						
	1	73	14.90						
	2	73	11.10						
	3	73	29.40						
	4	73	31.10						
	5	73	24.90						
	6	73	24.10						
501021	7	72	15.10	15	8.86				
	8	72	7.60	12	8.15				
	9	72	4.63						
	10	72	9.88	4	5.94	15	9.33		
	11	72	18.00	4	11.90				
	12	72	15.70	2	11.90				
	1	73	19.50	13	19.10				
	2	73	14.50	10	14.00				
	3	73	38.20	10	23.20				
	4	73	40.50	7	42.70	15	19.70	21	35.40
	5	73	32.20	12	35.90				
	6	73	31.30	3	29.40				

TRIBUTARY FLOW INFORMATION FOR VERMONT 7/9/74

LAKE CODE 5610 LAKE ARROWHEAD

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
501041	7	72	1250.00	15	666.00				
	8	72	628.00	12	674.00				
	9	72	383.00						
	10	72	813.00	4	491.00	15	771.00		
	11	72	1493.00	4	981.00				
	12	72	1303.00	2	981.00				
	1	73	1606.00	13	1580.00				
	2	73	1195.00	21	1050.00				
	3	73	3165.00	10	1920.00				
	4	73	3342.00	7	3526.00	15	1626.00	21	2930.00
	5	73	2668.00	12	2965.00				
	6	73	2592.00	3	2432.00				
501042	7	72	1225.00	15	652.00				
	8	72	614.00	12	659.00				
	9	72	375.00						
	10	72	794.00	4	480.00	15	755.00		
	11	72	1464.00	4	960.00				
	12	72	1275.00	2	960.00				
	1	73	1570.00	13	1540.00				
	2	73	1171.00	21	1030.00				
	3	73	3104.00	10	1880.00				
	4	73	3272.00	7	3450.00	15	1592.00	21	2867.00
	5	73	2615.00	12	2902.00				
	6	73	2538.00	3	2340.00				

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APPENDIX B

PHYSICAL and CHEMICAL DATA

K - Value is less than indicated
J - Value known to be in error

STORET RETRIEVAL DATE 74/07/02

501001
44 40 51.0 073 06 02.0
LAKE ARROWHEAD
50 VERMONT

11EPALES
3

2111202
0009 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/02	15 31	0000	16.8	9.2	54	120	7.60	37	0.180	0.040	0.013	0.009
72/07/31	19 10	0000			52	105	8.40	27	0.170	0.060	0.015	0.011
	19 10	0005	21.2	9.8		110	7.60	28	0.210	0.060	0.016	0.010
72/10/05	09 10	0000			72			48	0.150	0.040	0.016	0.007
	09 10	0004						44	0.160	0.060	0.079	0.009

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/02	15 31	0000	20.5J
72/07/31	19 10	0000	5.0J
72/10/05	09 10	0000	2.5J

STORET RETRIEVAL DATE 74/07/02

501002
44 38 45.0 073 06 46.0
LAKE ARROWHEAD
50 VERMONT

11EPALES 2111202
3 0028 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/02	15 45	0000	19.3	8.6	60	120	7.60	36	0.170	0.070	0.008	0.004
	15 45	0015	19.4	7.8		120	7.40	37	0.170	0.050	0.006	0.004
72/07/31	19 30	0000			68	100	7.40	27	0.170	0.060	0.014	0.010
	19 30	0004	22.0	9.6		95	7.40	27	0.170	0.070	0.015	0.015
	19 30	0010	22.0	9.6		95	7.30	26	0.180	0.060	0.015	0.011
	19 30	0015	19.7	7.8		100	7.00					
	19 30	0019	19.5	8.0		100	6.90	27	0.230	0.100	0.020	0.011
	19 30	0024	19.3	7.6		100	7.00	27	0.240	0.110	0.019	0.014
72/10/05	08 50	0000			72	158	7.00	46	0.120	0.040	0.017	0.007
	08 50	0004	15.1	8.8		155	7.00	48	0.120	0.060	0.013	0.004
	08 50	0011	14.0	7.3		155	6.80	45	0.120	0.040	0.033	0.009

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/02	15 45	0000	8.1J
72/07/31	19 30	0000	11.7J
72/10/05	08 50	0000	3.1J

APPENDIX C

TRIBUTARY and WASTEWATER

TREATMENT PLANT DATA

K - Value is less than indicated
J - Value known to be in error

STORET RETRIEVAL DATE 74/07/02

501021 LS501021
44 41 00.0 073 05 30.0
NO NAME
50 7.5/MILTON
T/ARROWHEAD MTN LAKE
CEMENT BRDG ON ST RT 104A
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15	11 35		0.139	0.525	0.022	0.011	0.034
72/08/12	12 00		0.169	0.760	0.031	0.006	0.019
72/10/04	09 40		0.140	0.350	0.050	0.006	0.031
72/10/15	11 20		0.234	1.100	0.235	0.006	0.039
72/11/04	10 00		0.160	1.260	0.100	0.005K	0.024
72/12/02	10 40		0.340	0.780	0.024	0.005K	0.027
73/01/13	11 30		0.490	0.420	0.042		
73/02/10	13 45		0.450	0.420	0.054	0.006	0.015
73/03/10	10 00		0.252	0.600	0.094	0.011	0.070
73/04/07	10 10		0.154	0.420	0.062	0.009	0.025
73/04/15	14 00		0.370	0.400	0.076	0.009	0.020
73/04/21	09 30		0.250	1.200	0.290	0.008	0.030
73/05/12	11 00		0.063	0.650	0.093	0.005K	0.030
73/06/03	16 40		0.105	2.200	1.470	0.005K	0.035

STORET RETRIEVAL DATE 74/07/02

501031 LS501031
44 39 00.0 073 01 00.0
BROWNS RIVER
50 7.5/MILTON
T/ARROWHEAD MTN LAKE
BRDG ON ST RT 128
11EPALES
4 2111204
0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15	10 30		0.273	0.400	0.026	0.013	0.015
72/08/12	10 00		0.286	0.650	0.023	0.006	0.023
72/10/04	10 45		0.290	0.300	0.035	0.007	0.011
72/10/15	11 30		0.310	1.600	0.115	0.005K	0.023
72/11/04	09 40		0.330	0.580	0.044	0.007	0.038
72/12/02	09 35		0.360	0.390	0.033	0.005K	0.024
73/01/13	09 30		0.570	0.540	0.031	0.014	0.100
73/03/10	14 45		0.450	0.420	0.046	0.009	0.075
73/04/07	12 45		0.260	0.690	0.078	0.007	0.035
73/04/15	14 30		0.357	0.580	0.042	0.005K	0.015
73/04/21	10 00		0.490	0.840	0.407	0.005	0.030
73/05/12	13 50		0.168	0.380	0.032	0.005K	0.050
73/06/03	14 15		0.170	1.760	1.260	0.005K	0.030

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STORET RETRIEVAL DATE 74/07/02

501041 LS501041
44 38 15.0 073 06 30.0
LAMOILLE RIVER
50 7.5/MILTON
0/ARROWHEAD MTN LAKE
AT FENCE END ABOVE HWY BRDGIN MILTON
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/07/15	11 45		0.159	0.500	0.023	0.011	0.012
72/08/12	11 00		0.200	1.050	0.026	0.005K	0.021
72/10/04	09 00		0.182	0.250	0.072	0.006	0.019
72/10/15	11 00		0.234	0.550	0.091	0.005K	0.030
72/11/04	10 15		0.234	0.630	0.063	0.006	0.019
72/12/02	11 15		0.336	0.460	0.026	0.005K	0.025
73/01/13	11 00		0.520	1.500	0.086	0.008	0.020
73/03/10	12 05		0.560	0.400	0.097	0.014	0.060
73/04/07	05 15		0.330	0.540	0.058	0.009	0.030
73/04/15	13 45		0.440	0.880	0.680	0.006	0.015
73/04/21	10 50		0.370	0.210	0.056	0.005K	0.025
73/05/12	10 40		0.240	0.260	0.060	0.005K	0.015
73/06/03	11 15		0.190	2.050	1.790	0.005K	0.030

STORET RETRIEVAL DATE 74/07/02

501042 LS501042
44 41 00.0 073 04 00.0
LAMOILLE RIVER
50 7.5/MILTON
I/ARROWHEAD MTN LAKE
AT USGS GAGE STN ABOVE EASTGEORGIA
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/09/12	12 30		0.200	0.630	0.033	0.005K	0.025
72/10/04	10 00		0.250	0.300	0.060	0.006	0.012
72/10/15	11 20		0.234	0.500	0.083	0.005K	0.020
72/11/04	09 50		0.270	0.310	0.021	0.005K	0.022
72/12/02	10 00		0.357	0.860	0.052	0.005K	0.020
73/01/13	12 45		0.390	1.570	0.031	0.010	
73/03/10	13 00		0.610	0.670	0.100	0.014	0.065
73/04/07	11 00		0.357	0.295	0.042	0.007	0.035
73/04/15	14 15		0.440	0.390	0.250	0.006	0.015
73/04/21	12 30		0.360	0.260	0.052	0.005K	0.035
73/05/12	12 30		0.190	0.380	0.022	0.005K	0.040
73/06/03	13 45		0.176	1.760	1.400	0.005K	0.035

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STORET RETRIEVAL DATE 74/07/02

5010T1 P000900
44 38 00.0 072 11 00.0
JOHNSON
50 1/250000 LK CHAM
T/ARROWHEAD MTN LAKE
LAMOILLE RIVER
11EPA.ES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/01/10	08 00								
CP(T)-									
73/01/10	16 00		4.300	12.600	4.900	3.200	3.650	0.100	0.100
73/03/01	10 00								
CP(T)-									
73/03/03	10 00		1.320	16.000	9.200	3.100	3.100	0.100	0.120
73/04/19	10 00		0.400	6.600	5.000	0.770	0.893	0.200	0.150
73/05/31	08 00								
CP(T)-									
73/05/31	13 00		9.630	1.260	0.286	2.830	2.900	0.120	0.110
73/08/28	08 00								
CP(T)-									
73/08/31	11 00			1.600		0.850	4.700	0.120	0.115
73/09/24	07 00								
CP(T)-									
73/09/30	12 00		0.290	3.400	0.320	0.740	1.050	0.185	0.145
73/10/25	07 00								
CP(T)-									
73/10/25	12 00		0.720	16.500	5.700	2.850	3.900	0.145	0.155
73/11/26	07 00								
CP(T)-									
73/11/26	14 00		15.600	0.550	0.040K	3.150	3.500	0.140	0.150
73/12/28	07 00								
CP(T)-									
73/12/31	13 00		9.700	4.100	0.062	1.875	2.200	0.180	0.160
64/12/28	07 00								
CP(T)-									
74/01/02	13 00							0.180	0.160
74/01/29	08 00								
CP(T)-									
74/02/04	16 00		12.800	2.000	0.820	2.700	3.200	0.115	0.115
74/02/25	08 00								
CP(T)-									
74/03/01	13 00		1.400	8.900	3.600	4.900	5.500	0.160	0.169
74/03/25	12 00								
CP(T)-									
74/04/01	16 30		0.760	12.500	4.800	3.300	3.950	0.150	0.157

STORET RETRIEVAL DATE 74/07/02

5010T1 P000900
44 38 00.0 072 11 00.0
JOHNSON
50 1/250000 LK CHAM
T/ARROWHEAD MTN LAKE
LAMOILLE RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
74/04/26	07 00								
CP(T)-			3.500	3.400	0.530	1.250	1.700	0.180	0.193
74/05/01	16 00								